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# Campsite Impacts in Four Wildernesses in the South-Central United States

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Research Summary

Campsite impacts were studied in four wildernesses in the south-central United States—Caney Creek, AR, Upper Buffalo, AR, Hercules Glades, MO, and Garden of the Gods, IL. The number of campsites varied from 25 sites in Garden of the Gods to 91 sites in Caney Creek. Portions of Caney Creek Wilderness have both high densities of campsites and the most intensely impacted campsites. Compared with wildernesses in other regions, however, campsite densities in these wildernesses are generally low to moderate, and impact intensities on individual campsites are low.

Ground cover disturbance is more pronounced on these campsites than overstory disturbance. These campsites are unusual because of their low level of tree damage. Impacts are greatest on campsites located close to streams and on sites used by horse parties as well as hikers. Because campsite density caused more problems in these wildernesses than the intensity of impact on individual sites, management should focus on limiting the number of campsites. Management strategies, monitoring procedures, and educational programs are suggested for wilderness managers.

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# Campsite Impacts in Four Wildernesses in the South-Central United States

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## Introduction

Wildernesses are designated to preserve natural conditions and to provide opportunities for primitive recreation in a natural environment (Hendee and others 1990). Unfortunately, these management goals conflict, leaving wilderness managers with the unenviable task of striking a balance between them. Nowhere is this need for balance more evident than in managing the impacts of recreation use on campsites. Managers must allow some degradation of natural conditions on campsites, while seeking to keep degradation to an acceptable level.

Over the past several decades, campsite impact research has provided a firm foundation for campsite management programs in wilderness. The types and magnitude of campsite impacts have been described, and techniques have been developed for monitoring these impacts (Cole 1989; Marion 1991). This information is useful in defining limits of acceptable change (Stankey and others 1985) and for assessing where and when mitigation is needed. Relationships between use characteristics, environmental characteristics, and resultant campsite impacts have been analyzed (Cole 1994), providing strategies for keeping impacts to acceptable levels.

Most of this research has been conducted in the high-elevation wildernesses of the Western United States (Cole 1987). The few studies conducted in the eastern half of the United States were mostly in the Boundary Waters Canoe Area Wilderness in northern Minnesota (Frissell and Duncan 1965; Marion and Merriam 1985) or in the Appalachian Mountains (Bratton and others 1978; Hall 1989; Leung and Marion 1995; Rechlin 1973; Williams 1994). It is questionable whether research results from one part of the country can be applied elsewhere (Hall 1989).

The South-Central United States is one region of the country with a large concentration of wildernesses that has been neglected by research. The uplands of this region include the Ozark and Ouachita Mountains of northern Arkansas, eastern Oklahoma, southern Missouri, and adjacent south-

ern Illinois. Thirty wildernesses are concentrated in this 120,000 km<sup>2</sup> area.

We studied campsite impacts in four of these wildernesses (fig. 1)—Caney Creek, AR, Upper Buffalo, AR, Hercules Glades, MO, and Garden of the Gods, IL. Specific objectives were to characterize the extent and intensity of campsite impacts, assess variation in intensity of impact between these wildernesses, assess how impact intensity differs between campsites located in different environments and used by different user types, and compare the types and intensity of impact to those reported elsewhere. This information should allow wilderness managers in this region to tailor campsite impact standards, monitoring protocols and management programs to their situation.



**Figure 1**—Location of the Caney Creek, Upper Buffalo, Hercules Glades, and Garden of the Gods Wildernesses in the South-Central United States.

## Methods

In each wilderness, we searched for campsites along the entire trail system and in off-trail areas that looked suitable for camping. Campsites were usually defined by evidence of a campfire. Where campfire remains were the only evidence of use, sites were termed "trace sites." The only information collected on trace sites was the campsite location. More highly impacted sites were termed "well-established sites." Nine types of impact were assessed on well-established sites: campsite area, devegetated area, vegetation loss, increase in mineral soil exposure, damage to tree trunks, exposure of tree roots, social trails, developments, and cleanliness (Cole 1989).

Campsite boundaries were usually determined by the outer boundary of evident vegetation damage. Most campsites consist of a central area completely devoid of vegetation (devegetated area) and a sparsely vegetated outer portion of the campsite. Both campsite and devegetated areas were estimated by pacing

a length and width (if the area approximated a rectangle) or a radius (if the area approximated a circle).

We estimated the percent cover of vegetation and exposed mineral soil, in 25 percent cover classes, on both the campsite and an undisturbed control site. Estimates of vegetation loss and increase in soil exposure were obtained by calculating the difference between midpoints of these cover classes. Within campsite boundaries, we counted the number of trees that had been felled and those with scars clearly caused by humans, as well as the number of trees with roots exposed by trampling. We counted the number of social trails that connected the campsite to the trail, to other campsites, or to water. Finally, we counted the number of fire scars on each site, and noted the extent of development (for example, seats and fire rings) and the cleanliness of the site (litter and feces).

Two summary impact ratings were developed for each site. The first rating was calculated using data for the nine separate impact parameters (fig. 2). For each of these parameters, a rating of 1, 2, or 3 was

| Campground Impact Index  |  |   |   |                             |
|--|--|---|---|-----------------------------|
| Impact Rating (circle one category)  |  |   |   |                             |
|  | 1  | 2   | 3   | Calculation<br>Impact Index |
| 20. Vegetation loss  | (No difference in coverage)                        | (Difference one coverage class)                     | (Difference two or more coverage classes)         | 2                           |
| 21. Mineral soil increase  | (No difference in coverage)                        | (Difference one coverage class)                     | (Difference two or more coverage classes)         | 1                           |
| 22. Tree damage:<br>No. of trees scarred or felled<br><u>6</u>                   | (No more than broken lower branches)               | (1-8 scarred trees, or 1-3 badly scarred or felled) | (>8 scarred trees, or >3 badly scarred or felled) | 2                           |
| 23. Root exposure:<br>No. of trees with roots exposed<br><u>5</u><br>(estimated) | (None)   | (1-6 trees with roots exposed)                      | (>6 trees with roots exposed)                     | 2                           |
| 24. Development:   | (None)   | (1 fire ring with or without primitive log seat)    | (>1 fire ring or other major development)         | 3                           |
| 25. Cleanliness:<br>No. of fire scars<br><u>2</u>                                | (No more than scattered charcoal from 1 fire ring) | (Remnants of >1 fire ring, some litter or manure)   | (Human waste, much litter, or manure)             | 2                           |
| 26. Social trails:<br>No. of trails:<br><u>2</u>                                 | (No more than 1 discernible trail)                 | (2-3 discernible, max. 1 well worn)                 | (>3 discernible or more than 1 well worn)         | 2                           |
| 27. Camp area:<br>Estimated area:<br><u>750</u><br>(ft <sup>2</sup> )            | (540 ft <sup>2</sup> )                             | (540-1,700 ft <sup>2</sup> )                        | (>1,070 ft <sup>2</sup> )                         | 2                           |
| 28. Barren core camp area:<br>estimated area:<br><u>50</u><br>(ft <sup>2</sup> ) | (<54 ft <sup>2</sup> )                             | (54-540 ft <sup>2</sup> )                           | (>540 ft <sup>2</sup> )                           | 1                           |
| 29. Photo record _____   | 30. Impact index: _____                            |   |   | 1.9 (17/9)                  |

Figure 2—Form used to assess campsite impact and derive impact index.

**Table 1**—Characteristics of four South-Central United States wildernesses.

|  | Wilderness  |               |                 |                    |
|--|-------------|---------------|-----------------|--------------------|
|  | Caney Creek | Upper Buffalo | Hercules Glades | Garden of the Gods |
| Location                                 | Arkansas    | Arkansas      | Missouri        | Illinois           |
| Designation year                         | 1975        | 1975          | 1976            | 1990               |
| Elevational range (m)                    | 275-700     | 380-710       | 225-410         | 150-250            |
| Size (ha)                                | 5,854       | 4,286         | 4,984           | 1,333              |
| Recreation visitor-days (1993)           | 12,200      | 1,900         | 17,400          | 5,000              |
| Use density (recreation visitor-days/ha) | 2.08        | 0.44          | 3.49            | 3.75               |

assigned to the site, depending on the level of impact. For example, for tree root exposure a rating of 1 was assigned if there were no trees with exposed roots. A rating of 2 was assigned if roots were exposed on one to six trees. A rating of 3 was assigned if roots were exposed on more than six trees. The impact index is the mean of these nine impact ratings.

The second rating was used to compare these sites with sites studied elsewhere. This rating was a modified Frissell (1978) condition class. Condition classes ranging from 1 to 4 were (1) minimal impact, (2) vegetation loss confined to the central portion of the site, (3) vegetation lost over most of the site but little mineral soil exposure, and (4) vegetation lost and mineral soil exposed over most of the campsite.

## Results

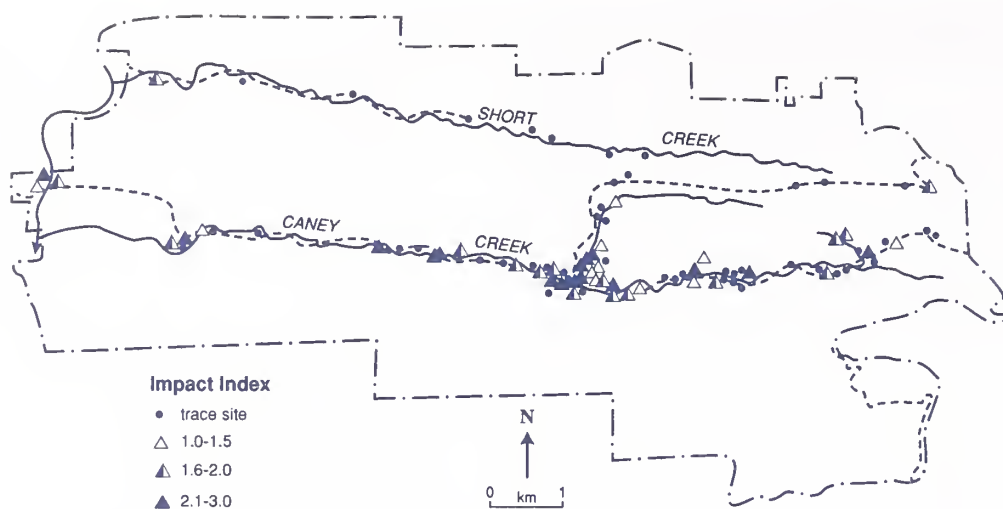
This section describes the characteristics of each individual wilderness (table 1) (including the number

and density of campsites) and the intensity of impact on well-established sites, compares impact intensities among the four wildernesses, and evaluates the extent to which topographic location and user type influence intensity of campsite impact.

### Caney Creek Wilderness

The Caney Creek Wilderness is in the Ouachita Mountains of west-central Arkansas and is the largest (5,854 ha) of the four wildernesses. Vegetation consists of a continuous, dense cover of oak-hickory-pine forest (Skeen and others 1993). Topography is dominated by two parallel creeks, Caney Creek and Short Creek, separated by long ridges, with local relief of more than 300 m (fig. 3). Most use (estimated at 12,200 recreation visitor-days in 1993) is concentrated along the Caney Creek trail corridor. This density of recreation use (2.08 recreation visitor-days per ha) exceeds that of most wildernesses (mean of 1.06 recreation visitor-days per ha in 1993 for the entire wilderness

**Figure 3**—Caney Creek Wilderness overview.



**Figure 4**—Location and condition (impact index) of campsites in the Caney Creek Wilderness.

system, excluding Alaska) (Cole, unpublished data). Most use is by overnight hikers, although horse groups visit the wilderness on rare occasions (Watson and others 1992).

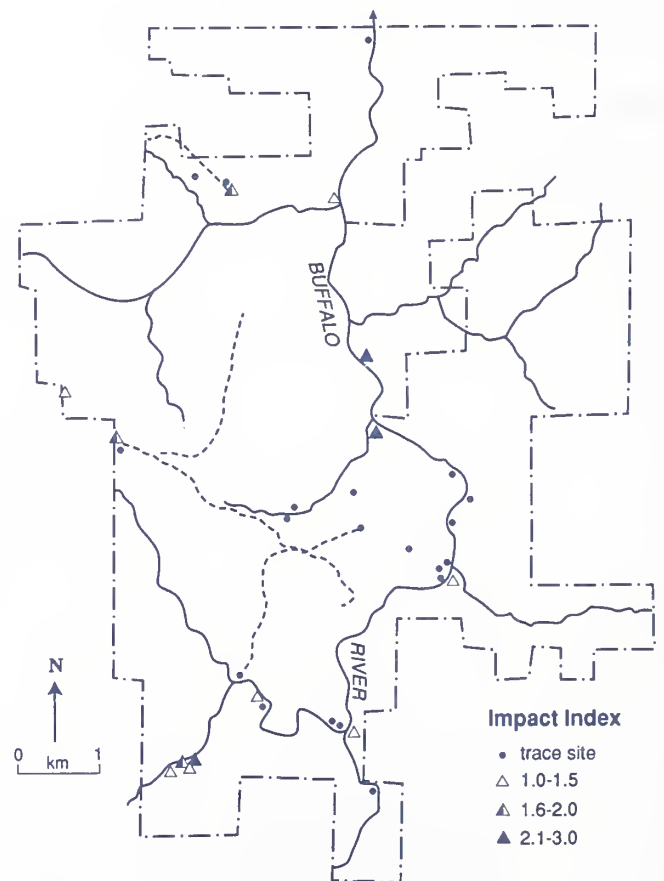
Of the 91 campsites in the Caney Creek Wilderness, 48 are trace sites and 43 are well-established sites. Although campsite density for the entire wilderness is only 1.8 campsites per km<sup>2</sup>, campsites are unevenly distributed across the landscape (fig. 4). About two-thirds of the campsites are located within 75 m of Caney Creek. Along this corridor, campsite density approaches 40 campsites per km<sup>2</sup> and campsites are frequently intervisible. Twenty-eight campsites are located within 1 km of the Caney Creek and Buckeye Mountain trail junction.

## Upper Buffalo Wilderness

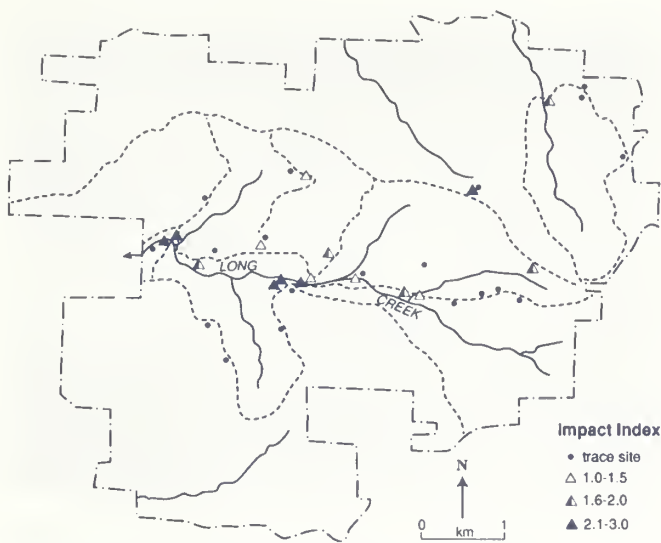
The Upper Buffalo Wilderness is in the Boston Mountains of northwestern Arkansas, the highest and most rugged portion of the Ozark Plateaus. The vegetation of this 4,286 ha area is a dense, continuous forest of oak-hickory on the uplands and western mesophytic forest along the Buffalo River (Bryant and others 1993). The topography is a rolling plateau, dissected by the 250 m gorge of the Buffalo River and its short tributaries. Estimated recreation use was about 1,900 visitor-days in 1993. Virtually all of this use was foot travel, and much of it was during the fall hunting season. This density of use (0.44 recreation visitor-days per ha) is the lowest of the four wildernesses and less than one-half of the mean use density of the wilderness system. Most use occurs along a few trails and along the Buffalo River.

Of the 33 campsites in the Upper Buffalo Wilderness, 20 are trace sites and 13 are well-established

sites. Compared with Caney Creek, total campsite density is low (0.8 campsites per km<sup>2</sup>), but like Caney Creek, campsites are highly concentrated along the primary drainage (fig. 5). Campsite density on the



**Figure 5**—Location and condition (impact index) of campsites in the Upper Buffalo Wilderness.



**Figure 6**—Location and condition (impact index) of campsites in the Hercules Glades Wilderness.

terraces and floodplain of the Buffalo River, where two-thirds of the campsites are located, is about 10 sites per km<sup>2</sup>. Only three sites are intervisible.

## Hercules Glades Wilderness

The Hercules Glades Wilderness is on the Ozark Plateau of southwestern Missouri. Vegetation of this 4,984 ha area consists of dense oak-hickory forest with open glades on shallow, droughty soils. The characteristic vegetation of these glades consists of redcedar (*Juniperus virginiana*) scattered within a perennial grassland (Quarterman and others 1993). Compared with the Arkansas wildernesses, topography is more intricately dissected but there is less local relief (maximum about 130 m). There is an extensive trail network, but most trails follow the ridgetops rather than the narrow drainages. Both day and overnight hiking are common, with much of the use occurring during the hunting season. Hiking is the most common method of travel, but horse groups probably visit this wilderness more frequently than any of the others. In 1993, recreation use was estimated at 17,400 recreation visitor-days. At 3.49 visitor-days per ha, this estimated density of use is more than three times the national average.

Of the 35 campsites in Hercules Glades Wilderness, 19 are trace sites and 16 are well-established sites. Campsite density is 0.7 sites per km<sup>2</sup>—the lowest density of the four wildernesses. Only about one-third of the campsites are located along the primary drainage, Long Creek, where campsite density is 14 sites per km<sup>2</sup> (fig. 6). Only two sites are intervisible.

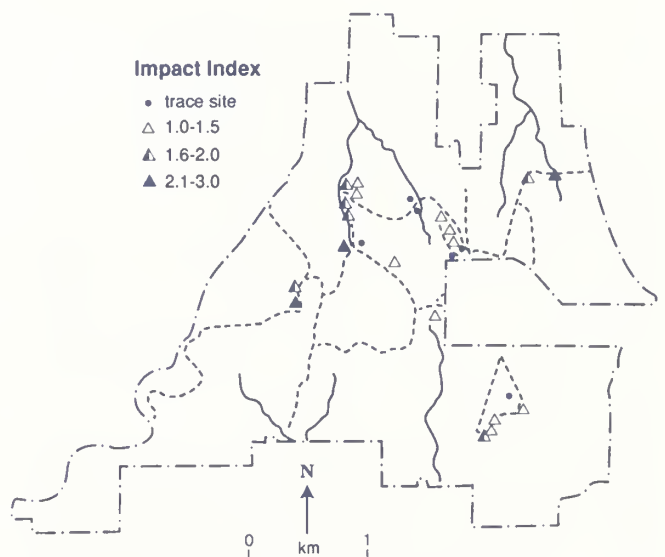
## Garden of the Gods Wilderness

The Garden of the Gods Wilderness is in the hill country of southeastern Illinois at the western fringe of the eastern Interior uplands. It is the smallest of the four wildernesses (1,333 ha). The vegetation is a dense, continuous cover of oak-hickory forest. Topography consists of broad, undulating ridges incised by narrow ravines. Local relief seldom exceeds 65 m. Sandstone outcrops create shelter bluff caves that were extensively used by Native Americans. In 1993, recreation use was estimated at 5,000 recreation visitor-days. If this estimate is accurate, this would be the most densely used of the four wildernesses (3.75 visitor-days per ha). Most of this use appears to be day-use, primarily by hikers but also by horse groups.

Of the 25 campsites in the Garden of the Gods Wilderness, 6 are trace sites and 19 are well-established sites. Campsite density is 1.9 sites per km<sup>2</sup>, the highest density of any of the four areas (fig. 7). It also has the largest proportion of well-established campsites—three quarters of the sites. Elsewhere, less than one-half of the campsites are well-established. Campsites are widely distributed and, in contrast to the other wildernesses, not concentrated along watercourses. Despite such a high campsite density, none of the campsites are intervisible.

## Campsite Impact Intensity

Impact intensity was only assessed in detail on the well-established campsites. The trace sites were all



**Figure 7**—Location and condition (impact index) of campsites in the Garden of the Gods Wilderness.

**Table 2**—Mean conditions on well-established campsites in each wilderness.

| Impact parameter                   | Wilderness    |               |                 |                    | <i>p</i> <sup>a</sup> |
|------------------------------------|---------------|---------------|-----------------|--------------------|-----------------------|
|                                    | Caney Creek   | Upper Buffalo | Hercules Glades | Garden of the Gods |                       |
|                                    | <i>n</i> = 43 | <i>n</i> = 13 | <i>n</i> = 16   | <i>n</i> = 19      |                       |
| Vegetation loss (percent)          |               |               |                 |                    |                       |
| Mean                               | 52a           | 27b           | 29b             | 23b                | 0.001                 |
| Range                              | 0-85          | 0-60          | 0-85            | 0-60               |                       |
| Mineral soil increase (percent)    |               |               |                 |                    |                       |
| Mean                               | 28            | 21            | 19              | 14                 | .20                   |
| Range                              | 0-85          | 0-85          | 0-60            | 0-85               |                       |
| Scarred/felled trees (number)      |               |               |                 |                    |                       |
| Mean                               | 3.1           | 1.2           | 4.3             | 2.7                | .25                   |
| Range                              | 0-16          | 0-15          | 0-27            | 0-11               |                       |
| Trees with exposed roots (number)  |               |               |                 |                    |                       |
| Mean                               | 1.0           | 0.3           | 0.9             | 0.3                | .21                   |
| Range                              | 0-7           | 0-11          | 0-7             | 0-1                |                       |
| Fire scars/rings (number)          |               |               |                 |                    |                       |
| Mean                               | 1.2           | 1.1           | 1.2             | 1.1                | .97                   |
| Range                              | 0-3           | 0-2           | 0-3             | 0-3                |                       |
| Social trails (number)             |               |               |                 |                    |                       |
| Mean                               | 1.9a          | 1.9a          | 1.6a            | 0.5b               | .01                   |
| Range                              | 0-6           | 0-5           | 0-5             | 0-6                |                       |
| Disturbed area (m <sup>2</sup> )   |               |               |                 |                    |                       |
| Mean                               | 65            | 62            | 80              | 53                 | .44                   |
| Range                              | 10-400        | 15-160        | 10-210          | 10-400             |                       |
| Devegetated area (m <sup>2</sup> ) |               |               |                 |                    |                       |
| Mean                               | 21a           | 8b            | 13ab            | 8b                 | .02                   |
| Range                              | 0-200         | 0-45          | 0-40            | 0-30               |                       |
| Impact index <sup>b</sup>          |               |               |                 |                    |                       |
| Mean                               | 1.9a          | 1.5b          | 1.7ab           | 1.5b               | .01                   |
| Range                              | 1.1-2.8       | 1.1-2.2       | 1.1-2.6         | 1.1-2.3            |                       |

<sup>a</sup>One-way analysis of variance. Values with different letters are significantly different (Duncan's multiple range test,  $\alpha = 0.05$ ).

<sup>b</sup>Impact index is the mean rating, from 1 (low) to 3 (high), for each of the nine individual impact parameters.

minimally affected by camping, and only their location was recorded. Many of the well-established campsites have experienced substantial ground cover disturbance (table 2). Mean vegetation cover on Caney Creek campsites was 52 percent less than on adjacent control sites, suggesting that camping has typically destroyed about 50 percent of the original vegetation cover. The three other wildernesses also have campsites where most of the vegetation cover has been destroyed, but such high levels of vegetation loss are less common. Mean vegetation loss on campsites in these wildernesses was significantly less than in Caney Creek—approximately 25 percent.

Mineral soil exposure, resulting from removal of soil organic horizons, was also prevalent but less pronounced than vegetation loss on most campsites (table 2). Most control sites had no soil exposure, but mean soil exposure on campsites was typically between 15 and 30 percent. In each of the four wildernesses, however, there were campsites on which the ground cover was almost entirely exposed mineral soil.

Tree damage was relatively minor on most sites in all of the wildernesses. Typically, a few trees per campsite were scarred, felled, or had their roots exposed by trampling. The site with the most tree damage, a site in Hercules Glades, had 27 scarred or felled trees and seven trees with exposed roots.

Most campsites had only one fire ring or fire scar and only one or two social trails connecting the site to the main trail or to water. Although some campsites in Garden of the Gods had as many as six social trails, as was the case in the other wildernesses, many sites had no social trails. Consequently, campsites in Garden of the Gods were significantly different from those elsewhere, having fewer trails.

The area disturbed by camping is typically 70 to 80 m<sup>2</sup> per campsite and does not vary significantly between wildernesses (table 2). The largest campsites, sites at Caney Creek and Garden of the Gods, are about 400 m<sup>2</sup>. Campsites at Caney Creek typically have larger devegetated areas than campsites elsewhere (fig. 8). The site with the largest devegetated area (200 m<sup>2</sup>) is also found at Caney Creek.



**Figure 8**—One of the highly impacted campsites in the Caney Creek Wilderness, illustrating the large area without ground vegetation.

Because there is more pronounced vegetation damage on Caney Creek campsites, impact indexes (an indicator of total impact) were significantly higher at Caney Creek than at Upper Buffalo or Garden of the Gods. The mean campsite impact index for Hercules Glades was lower than at Caney Creek but higher than at Upper Buffalo and Garden of the Gods. Caney Creek had several times as many substantially impacted sites (with index ratings greater than 2.0) than any of the other wildernesses, but the proportion of sites that are substantially impacted is similar at Caney Creek and Hercules Glades.

## Impact Intensity Factors

Impact intensity is largely determined by characteristics of the site that influence its durability as well as by the amount and type of use that it receives (Cole 1994). Most campsites were along creeks, on terraces above creeks, or on upland ridgetops. For all impact parameters, except for the number of fire rings and the number of scarred trees, impacts were significantly more pronounced on sites located along creeks (table 3). Campsites located on ridgetops were the least intensely affected. These differences may reflect higher use levels close to creeks as well as differences in site durability; however, the lack of site-specific data on use levels makes it impossible to differentiate between these two potential causal factors.

Sites used by horse groups and hikers were more highly impacted (higher impact indexes) than sites used only by hikers (table 4). Horse-hiker sites were larger, had more exposed mineral soil, and had more tree damage than hiker-only sites. Vegetation loss, devegetated area, number of fire rings or scars, and number of social trails did not differ significantly with

**Table 3**—Mean conditions on well-established campsites occupying different topographic positions.

| Impact parameter                   | Topographic position |               |               | <i>p</i> <sup>a</sup> |
|------------------------------------|----------------------|---------------|---------------|-----------------------|
|                                    | Creek bottom         | Terrace       | Ridgetop      |                       |
|                                    | <i>n</i> = 39        | <i>n</i> = 24 | <i>n</i> = 21 |                       |
| Vegetation loss (percent)          | 48a                  | 38ab          | 27b           | 0.01                  |
| Mineral soil increase (percent)    | 29a                  | 16b           | 14b           | .02                   |
| Scarred/felled trees (number)      | 3.3                  | 2.0           | 1.6           | .10                   |
| Trees with exposed roots (number)  | 1.1a                 | 0.4b          | 0.1b          | .01                   |
| Fire scars/rings (number)          | 1.2                  | 1.0           | 1.1           | .53                   |
| Social trails (number)             | 2.2a                 | 1.7a          | 0.5b          | .001                  |
| Disturbed area (m <sup>2</sup> )   | 82a                  | 52b           | 52b           | .01                   |
| Devegetated area (m <sup>2</sup> ) | 20a                  | 12ab          | 4b            | .01                   |
| Impact index <sup>b</sup>          | 2.0a                 | 1.6b          | 1.4b          | .001                  |

<sup>a</sup>One-way analysis of variance. Values with different letters are significantly different (Duncan's multiple range test,  $\alpha = 0.05$ ).

<sup>b</sup>Impact index is the mean rating, from 1 (low) to 3 (high), for each of the nine individual impact parameters.

**Table 4**—Mean conditions on well-established campsites used only by hikers and those used by horse groups and hikers.

| Impact parameter                   | User group    |                         | <i>p</i> <sup>a</sup> |
|------------------------------------|---------------|-------------------------|-----------------------|
|                                    | Hikers only   | Horse groups and hikers |                       |
|                                    | <i>n</i> = 53 | <i>n</i> = 38           |                       |
| Vegetation loss (percent)          | 38            | 38                      | 0.91                  |
| Mineral soil increase (percent)    | 17            | 29                      | .01                   |
| Scarred/felled trees (number)      | 2.1           | 4.2                     | .01                   |
| Trees with exposed roots (number)  | 0.5           | 1.1                     | .03                   |
| Fire scars/rings (number)          | 1.1           | 1.2                     | .33                   |
| Social trails (number)             | 1.5           | 1.6                     | .40                   |
| Disturbed area (m <sup>2</sup> )   | 54            | 78                      | .01                   |
| Devegetated area (m <sup>2</sup> ) | 14            | 17                      | .27                   |
| Impact index <sup>b</sup>          | 1.7           | 1.9                     | .03                   |

<sup>a</sup>One-tailed *t*-test.

<sup>b</sup>Impact index is the mean rating, from 1 (low) to 3 (high), for each of the nine individual impact parameters.

user type. These relationships are identical to those reported in a study of campsites in the Bob Marshall Wilderness, MT, where horse-hiker sites were larger than hiker-only sites, with more exposed soil, more tree damage, and similar levels of vegetation impact (Cole 1983).

## Conclusions

Camping impacts are most pronounced in portions of the Caney Creek Wilderness. The Caney Creek trail corridor has the highest density of campsites and the most intensely impacted campsites. Elsewhere in the Caney Creek Wilderness, campsite impacts are less pronounced. Campsite impacts are also substantial in the Garden of the Gods and Hercules Glades Wildernesses, but for opposing reasons. Garden of the Gods has the highest wilderness-wide campsite density and

the largest proportion of well-established sites, but impact intensity on individual sites is generally low. Campsite density is low at Hercules Glades, but impact intensity is greater. Campsite impacts are least pronounced at Upper Buffalo; site density, the proportion of sites that are well-established, and impact intensity are all low.

Intensity of campsite impact is affected by use and site characteristics. We found large differences in impact between sites close to streams and sites on ridgetops. The more highly impacted condition of streamside campsites is probably a result of heavier use, but we were unable to separate the effects of use from site characteristics. Sites used by horse parties and hikers were more heavily impacted than those used only by hikers.

Campsite impacts are less pronounced in these wildernesses than in many of the other wildernesses where campsite impacts have been assessed. All of these areas have unusually low mean Frissell campsite condition ratings, an indicator of impact intensity (table 5). Campsite density, a measure of areal extent of impact, is also low to moderate compared with wildernesses in other regions. Reported recreation use densities are moderate to high in all of these wildernesses except Upper Buffalo. If these use estimates are reasonably accurate, per capita impacts are unusually low in this region, suggesting that the relatively low campsite impact levels reflect durable environmental conditions or the prevalence of low-impact users.

The low level of tree damage on campsites in these wildernesses is particularly notable. The wilderness with the most pronounced tree damage is Hercules Glades, with an average of five trees that are scarred, felled, or with exposed roots. The mean number of damaged trees at Upper Buffalo is only 1.5. In contrast, the mean number of damaged trees per campsite

is nine trees at the Boundary Waters Canoe Area, MN (Marion and Merriam 1985), 13 trees in the Eagle Cap Wilderness, OR (Cole 1982), and 63 trees in the Bob Marshall Wilderness, MT (Cole 1983). Possible explanations for the low levels of tree damage in wildernesses in this part of the country include environmental differences (such as greater downed wood production) and less damaging traditional styles of use (such as less use by horse parties—the primary reason tree damage is so high in the Bob Marshall).

## Management Implications

Campsite management programs can be tailored to the unique characteristics of the South-Central United States. Because the four wildernesses selected span much of the range of ecosystems and visitor-use situations found in the region, results are broadly applicable and can be used to develop campsite monitoring programs, management programs to mitigate existing problems, and visitor education programs to help limit future problems.

## Campsite Management

The relatively low levels of site impact in these wildernesses suggest that there is currently little reason for aggressive or heavy-handed campsite management programs, such as those that limit use or severely restrict user behavior. With the exception of some portions of the Caney Creek corridor, very little of these wildernesses has been impacted by camping. Several studies suggest that users expect and accept a certain amount of campsite impact (Roggenbuck and others 1993; Shindler and Shelby 1992). Most hikers in a portion of Mt. Jefferson Wilderness, OR, considered a devegetated area as large as 43 m<sup>2</sup> to be acceptable (Shelby and others 1988). Only in Caney Creek Wilderness are there campsites with a devegetated area substantially larger than 43 m<sup>2</sup>.

Where campsite density is high, such as in portions of Caney Creek Wilderness, it may be helpful to concentrate most camping on a dispersed subset of these sites, selecting them from those located farther from streams and trails. Concentrating use and impact on fewer campsites is particularly important to lessen the impact of horse groups. Sites used by horse groups were more intensely impacted than those used only by hikers, even though horse groups are uncommon in these wildernesses.

Campsite density could be reduced substantially by closing a few poorly located or excessively impacted campsites—a practice that has already been initiated at Caney Creek (fig. 9)—and by removing all evidence of previous use at trace sites. It is also important for visitors to stay off closed sites and to camp on open,

**Table 5**—Areal extent and intensity of campsite impacts in selected wildernesses in the United States.

| Wilderness                      | Campsite density      | Campsite condition <sup>a</sup> | Use intensity |
|---------------------------------|-----------------------|---------------------------------|---------------|
|                                 | Sites/km <sup>2</sup> | Mean                            | RVDs/ha       |
| Garden of the Gods, IL          | 1.9                   | 1.6                             | 3.8           |
| Hercules Glades, MO             | 0.7                   | 1.6                             | 3.5           |
| Upper Buffalo, AR               | 0.8                   | 1.4                             | 0.4           |
| Caney Creek, AR                 | 1.8                   | 1.9                             | 2.5           |
| Sequoia-Kings Canyon, CA*       | 2.2                   | 2.1                             | 1.8           |
| Eagle Cap, OR                   | 5.0                   | 2.0                             | 6.2           |
| Selway-Bitterroot, MT           | 0.7                   | 2.2                             | 1.2           |
| Boundary Waters Canoe Area, MN* | 0.7                   | 2.7                             | 2.4           |
| Great Smoky Mountains, TN/NC*   | 0.2                   | 3.0                             | 2.0           |
| Shenandoah, VA                  | 1.0                   | 2.2                             | 5.8           |
| James River Face, VA            | 0.6                   | 2.2                             | 1.2           |
| Peters Mountain, VA             | 0.3                   | 2.5                             | 6.8           |

<sup>a</sup>Mean modified Frissell condition class, from 1 (low impact) to 4 (high impact), estimated from ground cover disturbance data in areas denoted with an \*.



**Figure 9**—Caney Creek campsite, closed to allow recovery.

well-established sites in popular places or on previously unused sites in remote places (Cole and Krumpke 1992).

Designating specific sites for use by large groups and groups traveling on horseback could also be beneficial, selecting these sites from those that are already unusually large and with substantial horse-related impact. Groups could be informed of the location of these sites and encouraged to use them. Alternatively, their use could be required. Because of the current low level of impact, the educational approach might be preferable at this point. Campsite monitoring data could be used to assess the need for future regulation. Managers could also inform visitors of the location of dispersed campsites where they are less likely to encounter other visitors. Echelberger and others (1983), for example, found that wilderness visitors were favorably disposed to using dispersed campsites, but were unlikely to use them unless they were directed to the sites.

## Campsite Monitoring

The finding that campsite densities are moderately high, while impact intensities on individual sites are generally low, suggests that problems with too many

campsites are more likely than problems with individual sites that are too highly impacted, particularly for Caney Creek and similar wildernesses where camping is highly concentrated. Managers should develop indicators and monitoring procedures that focus on campsite densities.

Conditions on individual campsites should not be ignored entirely, however. Research suggests that visitors are concerned about vegetation loss, mineral soil exposure, and tree damage at campsites (Hollenhorst and Gardner 1994; Roggenbuck and others 1993). Because soil exposure and tree damage are not serious problems, at least at this time, vegetation loss is probably the impact of most concern.

Devegetated area is one of the indicators that best differentiates between the more intensely impacted campsites at Caney Creek and campsites elsewhere (table 2). A useful indicator that accounts for concerns about campsite density and vegetation loss is the extent of devegetated area within a destination area of some predefined size. Managers and the interested public should develop standards to define a maximum acceptable level of vegetation loss, using this indicator. For example, a standard may state that impacts are unacceptable if the total devegetated area on all

campsites within a 2 ha area exceeds 50 m<sup>2</sup>, limiting impact within any local area to either one substantially impacted campsite or to several lightly impacted campsites. Other destination area sizes and devegetated area limits could be used and should probably vary between the more popular and remote portions of the wilderness.

A simple monitoring system capable of collecting this information could involve locating all campsites, assigning a modified Frissell condition class rating to each site, as described earlier in this paper, and measuring devegetated area on all sites with a rating of 2 or more (see Cole 1989 for more detail). Depending on precision levels and other data collected, this system requires between 3 and 30 minutes of monitoring per site, and only needs to be conducted approximately every 5 years.

## Visitor Education

Managers need to develop visitor education programs that teach visitors low-impact practices, making future restrictions less likely. For example, the Leave No Trace program, sponsored by Federal land-managing agencies and the National Outdoor Leadership School, provides the basis for a consistent visitor education program (Cole and Krumpe 1992).

Because campsite density is the foremost problem, future proliferation of sites might be avoided if education programs succeed in persuading most visitors to camp on well-established sites. Visitors who wish to camp on previously unused sites need to know the importance of not camping on fragile sites, of eliminating all traces of use when they leave, and how to distinguish between fragile and durable sites. The large number of trace sites in all of these wildernesses (other than Garden of the Gods) indicates that many users do not follow these recommendations.

Some general guidelines about environmental characteristics that can be used to distinguish between durable and fragile campsites are applicable in a wide variety of wildernesses, including the general resistance of sites without ground cover vegetation or with dry, graminoid-dominated vegetation (Cole 1995; Kuss 1986).

Other distinguishing characteristics are specific to the South-Central United States and to the individual wildernesses within the region. For example, Hercules Glades is noted for open, grassy glades that occur on droughty, shallow soils. The perennial grass cover is very resistant when used infrequently by low-impact campers (fig. 10). In contrast, several of these wildernesses, particularly Garden of the Gods, have a number



**Figure 10**—Durable campsite located in a grassy glade in Hercules Glades Wilderness.



**Figure 11**—Typical shelter bluff campsite, located underneath an overhanging cliff.

of shelter bluff sites—shallow caves at the base of overhanging cliffs that offer sheltered campsites (fig. 11). The meager vegetation that can survive in front of these caves is highly fragile and often includes rare species. Many of these camps were used in prehistoric times and are culturally significant. Consequently, these shelter bluffs are poor sites for camping, and visitors should be encouraged to camp elsewhere.

Any information or education program, to be successful, must take user preferences for site attributes into account. Brunson and Shelby (1990) found, for example, that all users desire campsites with level ground, water close by, and shade or shelter. The importance of other attributes, such as scenic beauty, privacy, and plentiful firewood, varied among users. More research on visitor preferences for site attributes, including levels of previous impact, could improve the success of future campsite management programs.

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McEwen, Douglas; Cole, David N.; Simon, Mark. 1996. Campsite impacts in four wildernesses in the South-Central United States. Res. Pap. INT-RP-490. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 12 p.

Campsite impacts were studied in four wildernesses in the South-Central United States—Caney Creek, AR, Upper Buffalo, AR, Hercules Glades, MO, and Garden of the Gods, IL. Compared with wildernesses in other regions, campsite densities in these wildernesses are low to moderate, while impact intensities on individual campsites are low. Implications for monitoring procedures, management strategies, and educational programs are suggested.

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Keywords: Arkansas, Illinois, Missouri, monitoring, recreation use, visitor education, wilderness management, Caney Creek Wilderness, Upper Buffalo Wilderness, Hercules Glades Wilderness, Garden of the Gods Wilderness

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